INL Geothermal Energy Research and Development Activities

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"Subsurface" Activities

Current Activities

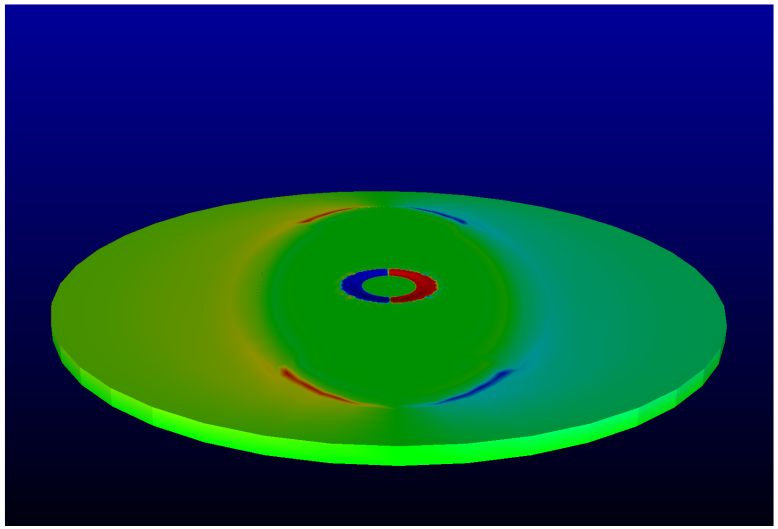
- Exploration
  - More “applied” effort
  - DOD facilities
- Reservoir Characterization
  - Advanced tracer and analysis tool development
  - Field and modeling
- Working Fluids
  - CO_2 and CO_2-water mixtures
  - Laboratory
- Reservoir Simulator Development
  - Next-Generation, HPC
  - EGS focused

- Exploration (Breckenridge, Wood, Podgorney Mines, Smith, others)
  - Collaborate with DOD
  - Explore geothermal potential at military installations
  - Currently conducting early evaluation of Hill AFB, also working at Mountain Home AFB

- Reservoir Characterization (Mattson, Plummer, Hull, Palmer, Miller)
  - *Develop reactive tracers*
  - Use breakthrough curves to estimate reservoir parameters, then predict thermal drawdown
  - *Testing at/collaborating with US Geothermal at Raft River*

- Working Fluids (Redden, others)
  - Focus on geochemistry of CO2-water mixtures
  - Fracture-fluid interactions
  - Collaboration with LBL and USGS

- Simulator Development (Podgorney, Huang, Gaston, Permann, Guo, Deng, Lu, others)
  - Focus on coupled THM processes
  - Collaborate with Nuclear Fuels simulation group



Energy Conversion and Analysis

Energy Conversion Activities at INL

- Work in this area has been conducted since the mid 1970's
  - Raft River
    - Heat exchangers
    - Materials – corrosion and scaling
    - Automated operation of small plant
    - 5 MW binary plant – dual boiling
  - Advanced cycles
    - Supercritical cycles
    - Mixed working fluids
    - Modified turbine inlet conditions (allow two-phase expansion in turbines)
  - Operation Issues
    - Real-time measurement of chemical species in process streams (hydrogen sulfide, hydrogen chloride)
    - Steam quality
    - Continuous removal of non-condensable gases from binary working fluids

Current Energy Conversion Activities

1. Develop analysis tools and methods for DOE (Mines, Wendt, Plum)
   - For each phase of geothermal project, predict capital and operating costs that phase's contribution of power generation costs
   - Project the impact of technology improvements on power generation costs
   - Current emphasis is on improving methods for estimate costs for drilling and exploration activities
   - Evaluate costs for atypical scenarios, generally associated with the development of EGS resources
2. Air-cooled condensers in binary plants (Mines, others)
   - Large amounts of heat are rejected (90% or more of heat removed from geothermal fluid)
   - Water not available (likely case with EGS) for heat rejection → air cooling
   - Air poor heat transfer fluid → condenser costs can be 1/3 or more of total plant cost

Air Cooled Condensers

- Examining benefits and costs for technologies having
  - potential to increase performance of air-cooled binary plants
  - no consumptive use of water
- Design approaches that can increase power production over life of plant without substantial cost increases
- Models developed (based on operating plants) that
  - Predict output with varying ambient and resource temperatures
  - Incorporate different components/concepts
- Emphasis currently on defining issues associated with using mixed working fluids in these air-cooled condensers, and identifying probable designs that will achieve the benefits associated with mixtures
  - Using prior test data for in-tube condensation of mixed fluids as basis for determination of heat transfer coefficients
  - Using commercially available software to assess condenser design and performance with mixed working fluids